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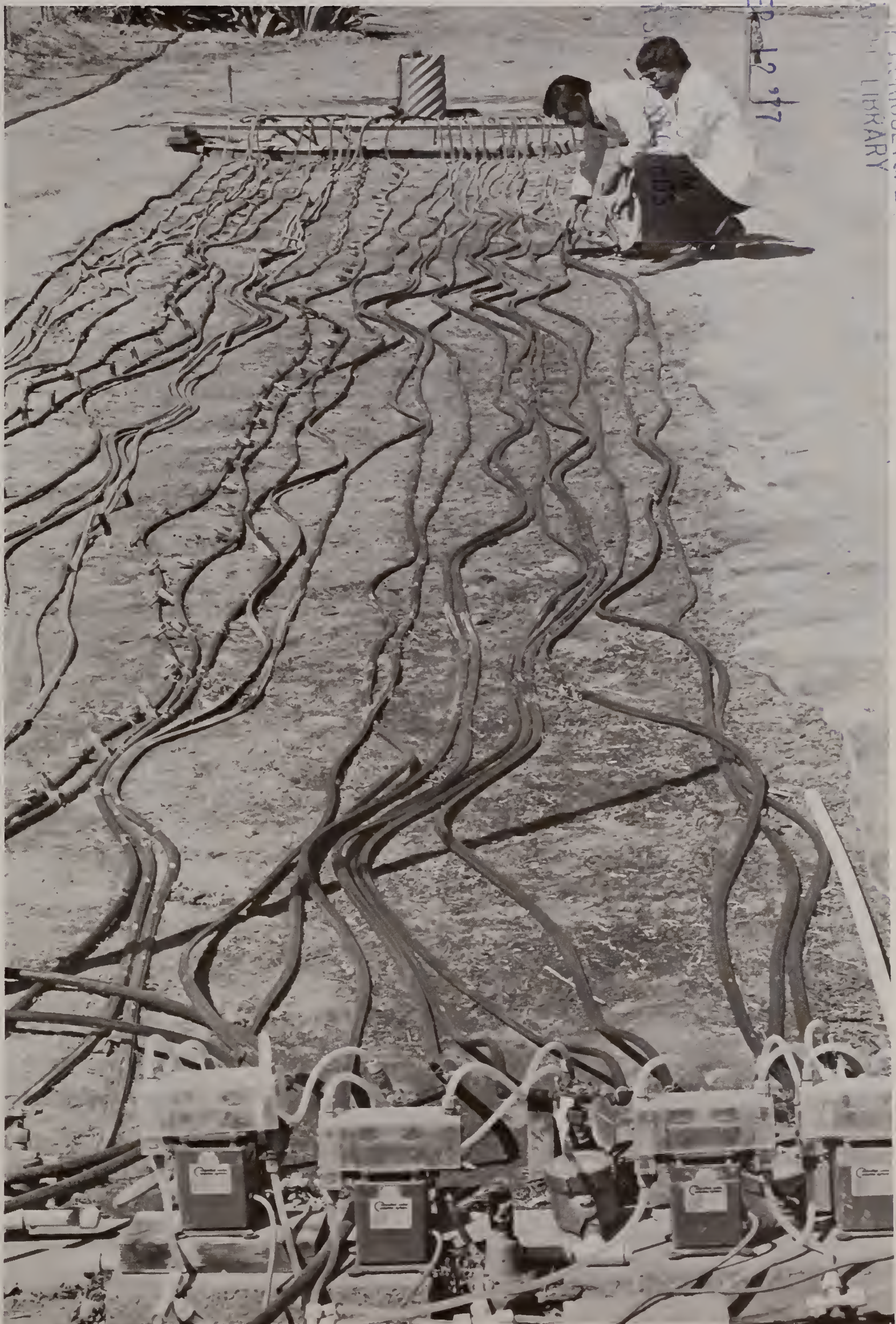

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August 1977/Vol. 26, No. 2

Manipulating Nature—Apis Mellifera

Apis mellifera (western honey bees) have been buzzing around the flowers for thousands of years. In fact, they were here before *Homo sapiens* and they developed their present forms without our help or interference.

Primitive humans enjoyed the sticky sweet labor of the bees. A painting done during Mesolithic times (about 7000 B.C.) in a Spanish rock shelter shows a human figure in a tree—robbing a bees' nest.

Gradually, beekeepers began to build hives of local materials to replace the wild hives found in hollow tree trunks and caves.

Ancient Egyptians used smoke to drive bees from the hive and by Roman times, the bees were even fed. Protective clothing for beekeepers had been invented by the Middle Ages.

No honey bees are native to North America—although there are a number of native wild bees. All honey bees originated in Europe, Africa, or Asia. Early settlers in each part of the New World brought beehives with them—the first record of honey bees in North America was in 1638.

Perhaps no fact of life has puzzled humans more than bee reproduction. In typical male chauvinistic manner, Aristotle believed that a "king" bee ruled the hive. The "king's" true sex was determined by 1600, but as late as 1750, beekeepers thought that drones fertilized the eggs after the queen laid them.

Today's domestic honey bees are not the result of manipulating nature, but the raw material for it.

The breakthrough in controlling the queen bee's mating came in the 1940's, when artificial insemination equipment was perfected. Because drones hatch from unfertilized eggs, their genetic makeup duplicates that of the queen. Thus, controlled matings were possible, using classical inbreeding and hybridization techniques. In egg laying, as well as in honey production, hybrids usually surpass control strains.

Along with studying bee behavior, genetics, and diseases, ARS scientists are studying the movement and characteristics of Africanized bees in South America. Popular press reports that give inaccurate and emotionalized accounts about "killer bees" may present problems for American beekeepers.

In time, agricultural scientists hope to manipulate *Apis mellifera* to produce more honey, swarm less, be more disease resistant, overwinter better, and sting less.

While the scientists are busy manipulating the bees, however, we are free to savor the sweet, sticky stuff our primitive ancestors so blatantly plundered.—*M.M.M.*

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COVER: Prevention of physical, chemical, and biological clogging of drip irrigation emitters through filtration, flushing, and chemical treatment is the aim of researchers at the U.S. Water Conservation Laboratory, Phonix, AZ. Here, chemist Francis J. Nakayama and soil scientist Richard G. Gilbert monitor emitter efficiency at their "emitter farm" where different chemical treatments at various concentrations are tested to establish guidelines for emitter maintenance (377X340-15). Article begins on page 8.

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Mr. Delfel removes needles and branch samples from a Japanese plum-yew tree. The samples will be surface sterilized in mecuric chloride solution and placed in standard nutrient medium in research aimed at controlling the production of antitumor alkaloids (0477X485–16).

Looking at Potential Leukemia Inhibitors

A TREE grows in an ARS laboratory, but the planting was no Arbor day event.

Chopped needles and branches, cut from a Japanese plum-yew more than 2 years ago, grow without roots on a nutrient medium in laboratory vials. They produce compounds that inhibit leukemia in laboratory mice.

The "gardeners" are two ARS chemists. Norman E. Delfel and John A. Rothfus are not only producing leukemia inhibitors in plum-yew tissue cultures for the first time, but they have discovered a new, related compound.

Some of their colleagues at the Northern Regional Research Center (1815 N. University St., Peoria, IL 61604) found the leukemia inhibitors in plum-yew (*Cephalotaxus harringtonia*) in 1969 while screening plant materials for anticancer compounds. Chemists Richard G. Powell, David Weisleder, Cecil R. Smith, Jr., and Kenneth L. Mikolajczak extracted and purified the compounds, determined their chemical nature and studied ways to synthesize them.

Scientists in the National Cancer Institute of the Department of Health, Education, and Welfare evaluated the compounds against leukemia in laboratory mice.

Additional quantities are needed for

further testing, but the trees are scarce in the United States and grow slowly. The *Cephalotaxus* genus is native to eastern Asia. One of its main habitats is the interior of the Chinese mainland.

"Supplies of plum-yew in the United States are essentially exhausted," says Mr. Delfel. "As a possible solution, we are investigating the production of the compounds in cultured tissues."

Cut pieces of Japanese plum-yew needles and branches develop callus tissue on a medium containing sugar, minerals, protein, vitamins, and hormones. The tissue grows without differentiating to form roots or shoots. Cells in this undifferentiated callus are like the cells in plant scar tissue—pruning cuts for example.

Some of the plum-yew callus has been growing more than 2 years under laboratory fluorescent lights, at 22° to 28° C (72° to 82° F) and with transfer to fresh medium about every 3 months.

"The callus tissues look a lot like cooked cauliflower," Mr. Delfel says. "Young tissues are light yellowish to yellow brown because the sugar in the medium tends to discourage chlorophyll formation. However, tissues older than 4 to 5 months, when the sugar is depleted, range from green to brown or yellow to white."

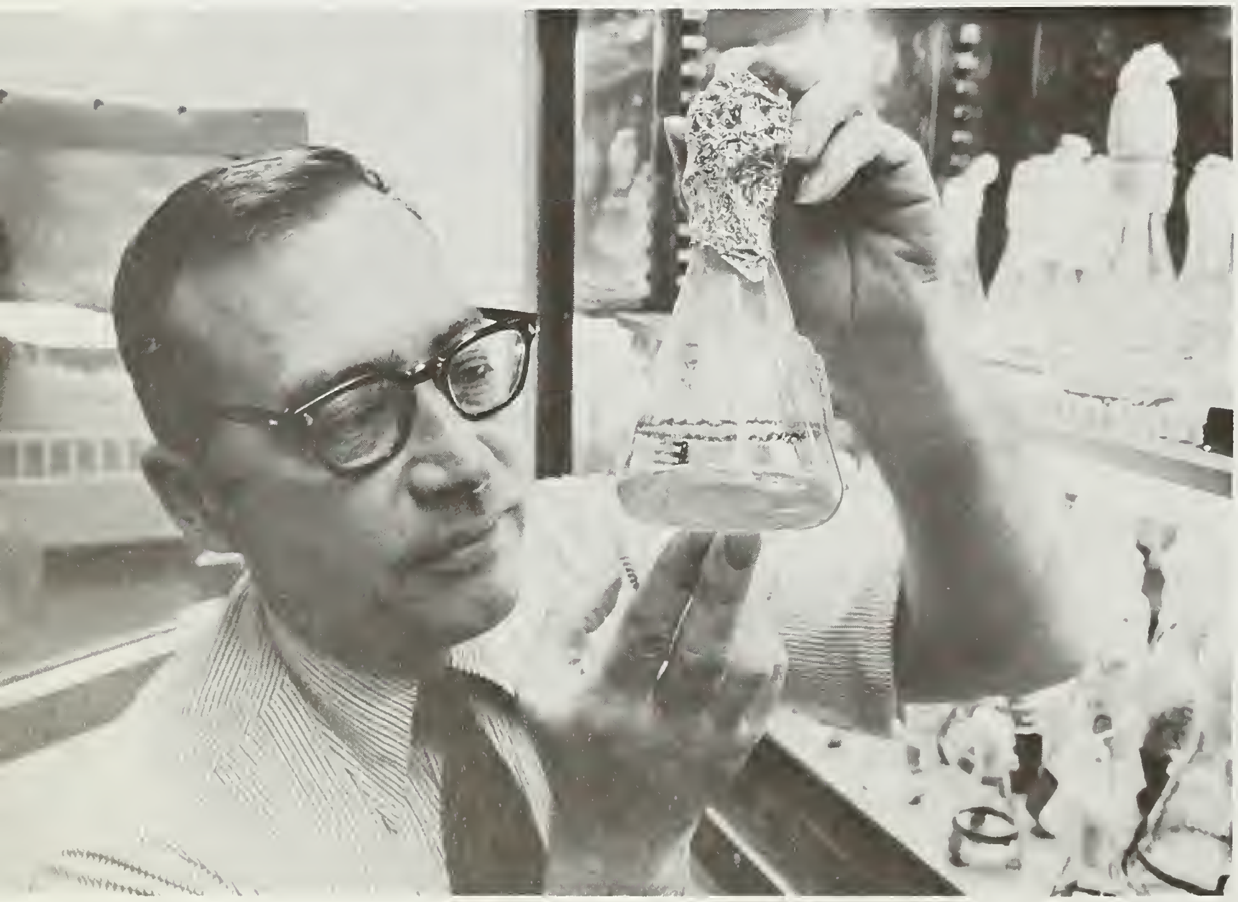
The chemists find that both callus and medium contain cephalotaxine, an inactive compound, and three active leukemia inhibitors derived from it, harringtonine, homoharringtonine, and isoharringtonine. The amount of these four alkaloids, or compounds, increases with the age of the tissue culture from 3 to 6 months.

The chemists find a fourth active alkaloid, deoxyharringtonine, only in the medium. The amount does not increase after 3 months. They have found a new cephalotaxine ester, homodeoxyharringtonine, also only in the medium.

"The deoxy compounds may be precursors or forerunners in the cells' synthesis of the other esters of cephalotaxine," Mr. Delfel says. "The fact that the cells secrete the active esters into the medium is favorable to possible commercial production at some future time."

Plum-yew callus grown under fluorescent lights is studied by biologist Leslie J. Smith. She is looking for subtle changes in the callus that would indicate root or plantlet formation. (0477X486–29).

Dr. Rothfus inspects suspension cultures of plum-yew callus cells grown in a controlled environment shaker. This preliminary research, if successful, may bring the leukemia inhibitor project one step closer to optimum conditions for commercial production (0477X488–35).



Although tissue cultures contain not more than 3 percent of the total alkaloid level in mature trees, the ratio of inactive cephalotaxine to its active esters, 60 to 40, is the same. In one young tree, however, this ratio was 5 to 95.

The differences between these ratios suggest to Mr. Delfel that plum-yew cultures might be regulated to increase the production of homoharringtonine, the most active leukemia inhibitor.

"Successful culture of cells from this rare and slow-growing plant might lead to production of the alkaloids in quantities needed for their thorough evaluations as chemotherapeutics." He expects no immediate solution to the supply problem, however. He points out, "We plan studies to increase the growth rate of the callus, to adapt the cells to liquid media and to increase yields of the leukemia inhibitors, especially homoharringtonine."—*D.H.M.*

Spearmint Mutations Resist Wilt

SEVERAL new strains of spearmint, mutations created by exposure to gamma radiation, show great promise as being resistant to Verticillium wilt disease.

Agronomic and quality tests will be required before the new varieties are released to growers; however, in three greenhouse tests and two preliminary field tests, the mutations displayed high wilt resistance.

Spearmint oil is widely used to flavor chewing gum, dentifrice, and mouthwash. Last year over 1.7 million pounds were produced, at a value of more than $18.5 million. The Scotch spearmint variety is preferred by consumers for its flavor, but this variety is highly susceptible to wilt.

Each year losses total nearly 10 percent of the crop. When wilt infects a field, the spearmint is wiped out and can't be regrown for 8 to 10 years. Though stubble flaming, limited tillage, soil fumigation, crop rotation, and deep plowing offer some wilt control, the ideal solution is developing wilt-resistant varieties.

ARS plant pathologists Chester E. Horner (Oregon State University, Room 2080, Corvallis, OR 97331), and Hassan A. Melouk (Oklahoma State University, 501 Life Sciences West, Stillwater, OK 74074), borrowed from a technique that employed gamma radiation to develop wilt-resistant peppermint. They improved upon this technique to create, select, and evaluate Scotch spearmint mutants displaying Verticillium resistance.

They exposed their spearmint mutants to ideal disease development conditions, which enabled them to develop wilt-resistant varieties in a relatively short period (4 years). Normally, breeding a plant variety for disease resistance requires many years of screening numerous generations.

Breeders can apply this timesaving technique to other vegetatively propagated crops in developing plant varieties that possess specific characteristics—*L.C.Y.*

Increasing shelf life

A NEW packaging technique can add months to the shelf life of nuts and such hard-to-keep cereal grains as brown rice.

Developed by ARS chemist Charles E. Holaday and industrial engineer Whit O. Slay, at the ARS National Peanut Research Laboratory (P.O. Box 110, Dawson, GA 31742), the technique takes advantage of the carbon dioxide-sorbing characteristics of the seeds.

The process is simple and economical. It involves placing the nuts or grain in a plastic bag impervious to carbon dioxide, flushing with carbon dioxide and heat sealing the bag.

Almost immediately the seeds begin to sorb the carbon dioxide and within 24 hours the process is complete, leaving the seeds in a vacuum.

The researchers say the sorption phenomenon is similar to that in activated charcoal. The carbon dioxide is believed to be held in solid solution inside the pores of the seed.

The technique is economical and lends itself to production-line packaging. It should have several applications including small retail packages and larger bulk packages. No refrigeration or other environmental safeguards are required.

Research at the National Peanut Research Laboratory has shown that raw peanuts packaged by the new technique have retained their freshness and flavor for at least 8 months while roasted peanuts have been stored up to 4 months without losing their freshness. Studies are now under way to determine how long peanuts and other products packaged by the technique will retain their original quality.—*V.R.B.*

Fruit harvester of the not-so-distant future: an artist's conception. This multipurpose tree trimmer and harvester can pick fruit and transfer it to bulk carriers, shape trees for the most effective light penetration, apply herbicides and fungicides, and apply and recirculate insecticides (PN–4137).

Shaping Up Fruit Trees

TOMORROW'S apple trees may be pruned in boxy or angular shapes to increase production and accommodate a new kind of over-the-row harvester.

Present-day mechanical fruit tree harvesters were adapted to trees as they have been conventionally pruned. In the future, however, fruit trees may be adapted to the harvesters instead. And even more futuristic harvesters may have attachments for pruning, spraying, and applying growth retardants and herbicides as well as for harvesting.

When shaping trees, pruned branches are shredded and dropped on the sod as mulch. At the same time, growth retardants are sprayed on the tops of the trees. Through genetic research, fruit trees will be bred to a size (not shape) that is ideal for the fruit, the climate, and the harvester as well (PN–4138).

A complete mechanized system for fruit culture is under development by ARS agricultural engineers Bernard R. Tennes and plant pathologist Clyde L. Burton (Agricultural Engineering Building, Michigan State University, East Lansing, MI 48823). They are collaborating with scientists in several disciplines concerned with fruit production and with equipment manufacturers and growers.

The machine they envision would be a powered frame, shaped like an inverted U, that would straddle the trees as it moves down the row. Attachments for harvesting and other orchard operations would operate from the sides and top of the frame.

Tree height and width would be restricted to promote penetration of sunlight to the center of the tree's crown or canopy and to fit dimensions of the machine. Dr. Tennes cites New York studies indicating that sunlight penetration determines fruiting depth into the canopy—2 to 3 feet in the case of apples. Maximum canopy size for entry of sun's rays at 45° or higher angle is 10 feet high and 6 feet wide. At least 4 feet of open space between canopies of trees would be needed.

The researchers suggest several boxy or angular shapes for apple trees of the future, within these limitations. All would be restricted to 6-foot width, with the lowest limbs at least 3 feet above the ground.

The spindle-bush tree would have a squared-off canopy 7 feet high. A similar T-shaped tree would have squared canopy 3 feet high, with the lowest limbs 5 feet from the ground. A variant, the double T, would have two boxlike canopies 2 feet high, one above the other, separated by 3 feet of limbless trunk. The canopy of the Y-shaped tree would be 7 feet high, with lower limbs pruned up to a 45° angle to the trunk and the center of the top also cut out at the same angle.

The spindlebush or double T trees would be planted allowing 6 feet of open space between canopies; the Y- and T-shaped trees could be spaced 2 feet closer.

Moving over the trees as a harvester, the machine might have a series of catching and shaking devices operating from both sides of the frame. Two trailers carrying bins would follow the machine and methods for transferring filled and empty bins would be part of a total handling and storage system. Provision might also be made for salvaging fruit dropped on the ground in harvesting, Dr. Tennes says.

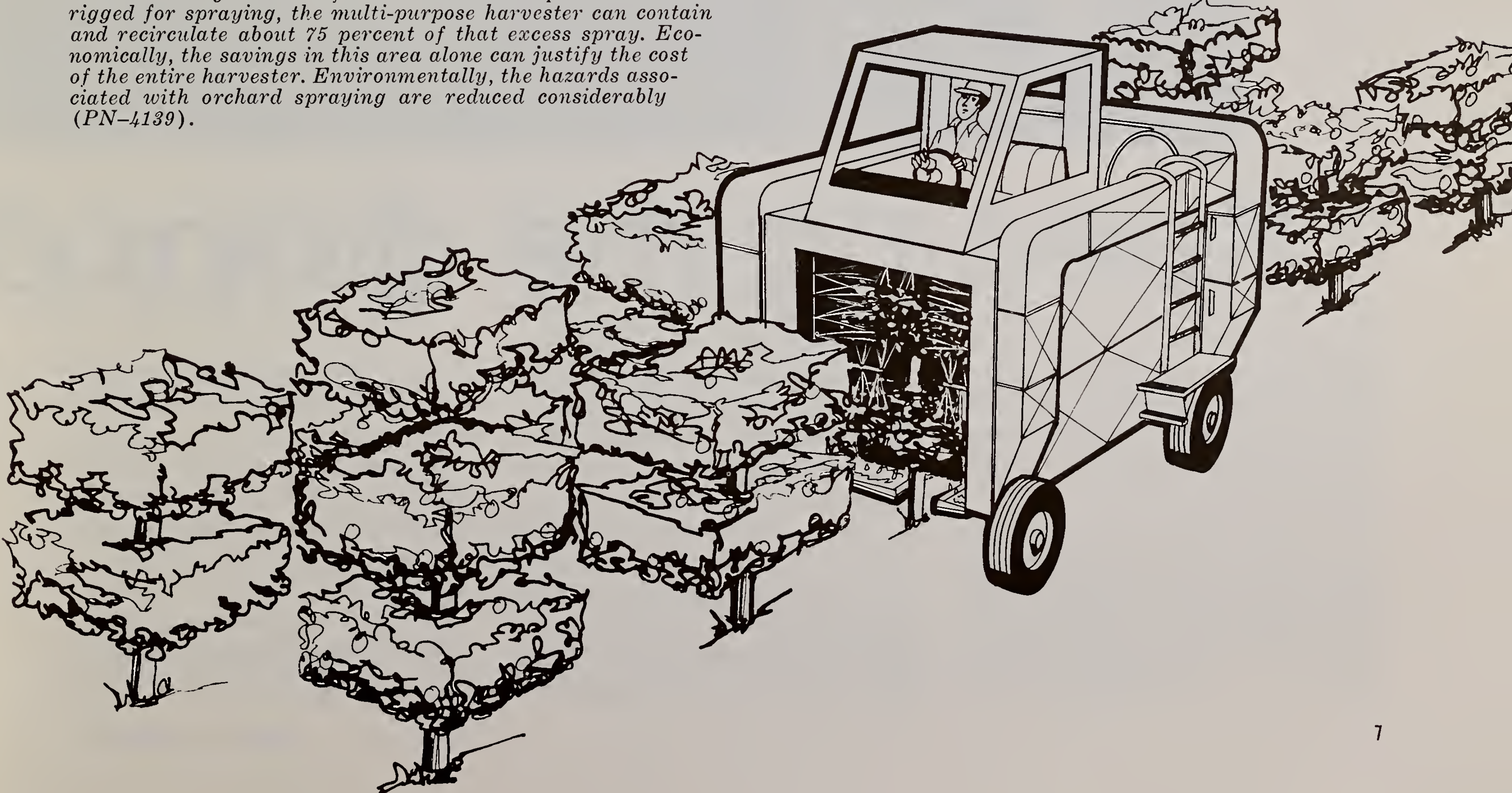
The researchers envision a pruning attachment for shaping and for removing branches, and the branches could be shredded and spread on the sod as a mulch. An attachment could apply a growth-retardant spray during the pruning operation to inhibit excessive top growth by the trees after pruning. A detachable spraying unit for applying insecticides and fungicides could be another part of the system, and herbicides for weed control in the sod could be put on as the trees are sprayed.

Finally, the system could include what Dr. Tennes calls a manpositioner, an enclosed chamber from which people could work comfortably and conveniently during planting, maintaining, and harvesting in the orchard.

Use of the mechanized fruit culture system would be practical in high-yielding orchards planted on slopes on which the machine could maneuver easily. Multiple use of the powered frame could reduce the grower's investment of other orchard equipment.

Minimum requirements, Dr. Tennes says, are an average yield of apples exceeding 678 bushels per acre, machine loss held to less than 20 percent, and high quality maintained in harvested fruit. If these conditions can be met, he calculates that the cost of the powered frame and attachments might be as much as $80,000 and still be economically feasible.—*W.W.M.*

In most spraying operations, approximately 95 percent of the insecticide drifts through the trees instead of settling on them—thus becoming a wasteful environmental pollutant. When rigged for spraying, the multi-purpose harvester can contain and recirculate about 75 percent of that excess spray. Economically, the savings in this area alone can justify the cost of the entire harvester. Environmentally, the hazards associated with orchard spraying are reduced considerably (PN–4139).



Below: Cover removed, an emitter displays one type of clogging problem: Carbonate salts have precipitated in the spiral grooves, drastically reducing water flow (0377X338–12). ***Bottom:*** *In this demonstration, an acid treatment helps dissolve carbonate buildup and remove other residual material. In actual practice, very low mounts of acid are added to the irrigation water at regular intervals (0377X338–19).*

Keeping the drops d

THE MOST serious problem in drip irrigation is plugging of emitters—tiny nozzles—caused by chemical or biological buildup in minute water passageways.

Preventing that buildup is a key to successfully operating most drip irrigation systems, ARS scientists found in several drip irrigation management experiments at various locations in Arizona.

Drip irrigation—the slow, pinpoint application of water through emitters—has many advantages: maximum use of water and fertilizer, low labor and operating expenses, and other pluses. The advantages are such that thousands of acres of cropland are irrigated that way in Arizona, California, Florida, Texas, Hawaii, and many other States. Australia, Israel, New Zealand, South Africa, and several other countries also have extensive acreage in irrigation systems. Total acreage keeps expanding every year.

But, like many innovations, guidelines must be developed, particularly for the filtration and chemical treatment of water for different types of emitters.

Obviously, clogging causes poor distribution of water and can cause severe crop reduction if emitters are clogged

Left: Frequently, emitter clogging problems from slime buildup are not evident until the second or third year of operation when preventive measures may be too late. To condense clogging studies to a shorter time period, scientists specially treated an irrigation water tank to greatly increase microbial activity. Dr. Gilbert is shown taking a water sample from the tank which he will analyze for microbial populations (0377X340–27). ***Below:*** *Mr. Bucks with one of the many types of emitters being used at present on crops such as citrus to improve irrigation efficiency. With energy-efficient drip irrigation, water can be applied directly to the trees at a very slow rate, avoiding water wastage due to runoff and resultant erosion (0377X339–7).*

Above: Dr. Nakayama checks chlorine level of water from pilot water treatment plant at Yuma. The introduction of minute quantities of chlorine into the irrigation system inhibits bacterial growth while helping to break up emitter clogging slime (0377X353–10).

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for any length of time.

While many manufacturers of drip equipment are aware of the clogging problem and have suggested preventive measures—filtration, flushing, chemical treatment—realistic guidelines on the use of those measures are scarce. Hence, the study currently in progress at Yuma and Phoenix.

There, ARS agricultural engineer Dale A. Bucks, chemist Francis S. Nakayama, and soil scientist Richard G. Gilbert (U.S. Water Conservation Laboratory, 4331 E. Broadway Rd., Phoenix, AZ 85040), in cooperation with the Arizona Agricultural Experiment Station, approached the clogging problem in two ways.

• They reclaimed older drip irrigation emitters and lines that were plugged to about 50 percent of their designed capacity.

• They prevented new emitters and lines from becoming plugged.

In reclaiming the old lines, the researchers added dilute sulfuric acid to the irrigation water entering the lines to bring the water to a pH of 2. Neutral water has a pH of 7; anything above that is alkaline—below is acidic.

At the same time they added the acid, the researchers added hypochlorite solution (laundry bleach) to get 100 parts per million (ppm) chlorine. One ppm is similar to adding one ounce of chlorine to 7,500 gallons of water.

The acid worked on scale built up from chemical reactions, and the chlorine helped to dissolve biological slimes while inhibiting bacterial growth. After the initial "slug" treatment, the emitters were operating at 95 percent of the designed flow.

After the 24- to 36-hour treatment, the entire system was treated with lower concentrations of chlorine and acid, keeping the system at about 1 ppm chlorine and a pH of 7. That continuous treatment maintained satisfactory emitter performance, not only in the older lines but in a newly installed system.

More research is being done to expand guidelines for maintaining emitter performance.

Meanwhile, the scientists recommend that irrigation water be filtered along with the acid-chlorine treatment to maintain drip irrigation systems.

At Yuma, the scientists filter Colorado River water with sand and screen filters—No. 20 silica sand and 200 mesh screen. The sand filters are backwashed daily during the summer months, and at least once a week or whenever the pressure-drop across the filter exceeds 10 pounds per square inch for other periods of the year. The screen filters are dismantled and cleaned with every backwash.—*J.P.D.*

Above: *At an experimental tract near Yuma, Mr. Bucks measures flow rate of an emitter. Variation in flow rates among individual emitters due to partial or complete blocking causes poor water distribution, resulting in irrigation inefficiency (0377X354–32).* ***Below:*** *Dr. Nakayama compares filtered (right) and unfiltered water from drip irrigation system installed at ARS' Yuma test site. Researchers have shown that filtering greatly improves emitter operation (0377X337–36).*

Below: *At the Yuma test site, Mr. Bucks dismantles a screen filter for routine inspection and cleaning. Clean, low sediment water helps keep the drip irrigation system operating with less clogging (0377X337–8).*

Recovering More $ $ From Sugerbeets

THE UNITED STATES has a large "sweet tooth"—nearly 100 pounds of sugar are consumed annually by each person. Because about half of all domestically processed sugar comes from sugarbeets, ARS researchers are looking for ways to extract as much sugar from beets as possible. Annually more than a half million tons of sugar in beets can not be extracted and is sold as molasses.

Sugar is obtained from a beet by slicing its root to extract the liquid or juice portion. Then the juice is purified and evaporated until sucrose crystallizes and becomes the granular table sugar with which we are more familiar. The remainder of the juice is molasses.

The amount of sugar that can be extracted from beets depends on amounts and kinds of non-sugar components that may tie up or trap sucrose in the extracted juice and prevent it from crystallizing. Trapped sugar is then sold as part of the molasses (which is about 50 percent sugar) and brings only $61 per ton instead of $340 per ton of wholesale refined sugar, based on recent figures.

"Every pound of these components in juice prevents crystallization of between 1.5 and 1.8 pounds of sucrose. This amounted to a total loss last year of a half million tons of sugar worth approximately $140 million wholesale," says ARS geneticist Garry A. Smith, Crops Research Laboratory (Colorado State University, Ft. Collins. CO 80523).

Beet growers are generally paid on the basis of weight of roots and the sucrose content. Sucrose content varies between 10 and 20 percent. If two growers each produce 1,000 tons of beets, the grower with 20 percent sucrose is paid approximately twice as much as the grower with only 10 percent sucrose.

Some sugar refiners are now paying growers on a third factor—purity. This is the percent of sucrose to all dissolved components in the juice. Purity usually ranges between 80 and 97 percent—the higher the purity, the more sugar that can be recovered. An increase of just 1 percent in purity can increase sugar yield by 5 pounds per ton of beets sliced.

These factors determine not only growers' incomes but also refiners' expenses. The higher the sucrose percent and purity, the less energy and time required for processing.

Nitrogen (N) fertilization stimulates growth of new leaves and since leaves are where photosynthesis produces sugar for storage in the root, adequate N in early growth is necessary to rapidly develop a full leaf canopy. This insures greater tonnage and higher sucrose percent.

Unfortunately, N also stimulates the production of sucrose-trapping components. Some are essential for beet growth but all prevent sugar recovery to some extent. These components are sometimes produced in excess of amounts needed for optimum sucrose production and storage.

Improving purity to get more recoverable sugar has been painfully slow. Before more rapid progress can be made, scientists need to know which components affect purity, which are under genetic control, and which component variables can be accurately and rapidly measured. Armed with this information, plant breeders can then "design" sugarbeets with higher purity.

Dr. Smith and ARS plant physiologist Susan S. Martin attempted to develop models that would identify components and field conditions having the greatest effect on beet purity. After two years research they conclude that a universal mathematical model for all combinations of plant variety, soil N fertility, and plant density likely doesn't exist. However any formula for individual varieties should include sodium, potassium, and betaine, and possibly nitrate N, amino N, and sucrose.

The scientists showed that the components, ash, total N, amino N, nitrate N, betain, sodium, and potassium, were greater while chloride, sucrose, and purity were less under high rather than low N fertilization. In the study, high fertilization was approximately 100 pounds per acre of actual N as ammonium nitrate. Low fertilization was residual N from the previous year's crop. This amounted to about 40 pounds per acre on plots in 1974 and 62 pounds per acre on other plots in 1975.

Concentrations of non-sugar components generally decreased with increasing plant density. These differences were largely but not entirely due to differing amounts of N available per plant. Densities used in the study ranged from 8,000 to 48,000 plants per acre.

ARS research continues on improving purity. Until this research is completed, Dr. Smith recommends that growers follow the advice of their local sugar refiner's field representative. They know the best fertilization rates and plant densities for fields in their area.—*D.H.S.*

Non-apis Bees--
The Pollinators

Hear the word "bee" and most of us probably flash on a busy little honeymaker who co-stars with birds in the story of sex. This is a highly overblown media image.

Honey bees are to bees what lhasa apsos (terriers) are to dogs—one member of a very large family—and all but a select few bees go through life celibate. Furthermore, making honey is not the sole justificaiton for the existence of bees; in fact, few bother to do so.

Pollination is the bee's greatest contribution to humans—perhaps one-third of our total diet is directly or indirectly dependent upon bee-pollinated plants—and it is the non-apis bees (the bees that don't make honey) who best excell at performing this function.

Non-apis bees can be more efficient pollinators than honey bees because they visit plants specifically to gather pollen. Most of the honey bee work force visit plants to gather nectar, only a small portion collects pollen and these specialists only visit plants with lots of easy-to-collect pollen. Also, because honey bees are subtropical insects, non-apis bees exist and operate under much broader environmental conditions.

Non-apis bees not only outperform the honey bees, but they greatly outnumber the honeymakers too. There are four species of honey bees in the world and only one of those is in the United States. There are 20,000 species of non-apis bees in the world, 5,000 in the United States, and maybe 10,000 more that have not yet been identified.

Yet for all of their plus points as pollinators, relatively little is known about non-apis bees, and even less is done to utilize their services. Honey bees have gotten and continue to get all the publicity, primarily because honey is something the general public can easily relate to; whereas, few persons outside of agriculture can relate to crop pollination.

Even those in agriculture often fail to look beyond the honey bee for pollination. The idea that the colonizing honey bees are easier to transport than non-apis bees for planned pollination has never been fully investigated and proven.

ARS researchers at the Bee Biology and Systemics Laboratory (UMC 53, Natural Resources-Biology Bldg., Rm. 261, Logan, UT 84322), are working to change this situation. The non-apis bee lab is manned by research leader and entomologist Frank D. Parker, and entomologists Philip F. Torchio, and William P. Nye, and it is the only Federal bee lab working with non-apis bees. Its chief function is to find the best possible pollinators for any given insect-pollinated crop, and this search is often worldwide in scope.

Federal programs to obtain pollinators of specific crops have been established with the governments of India, Pakistan, Egypt, Poland, and Spain. In addition, the ARS researchers make informal requests for bees from cooperating scientists in Sweden, Denmark, and France.

When samples of a desired bee are received from another country, those bees are immediately quarantined to destroy parasites, predators and diseases that might be present.

After the quarantine period, a generation of the bee species is raised in the controlled environment of a greenhouse to insure that the insects are pest-free, and to study and to confirm the basic biology of the bee. This is done to ascertain that the bee is what it has been reported to be.

Next, a field study is run with the bees confined to a large cage. Again the bees are carefully scrutinized for any undesirable habits or effects on the environment.

The following season, the field study bees are released from their cages so that they may be observed in a natural setting and their performances evaluated. A followup field study to confirm previous test results is conducted, and if all goes well, the bees are released to become established in States where they're needed.

Once a bee species is established in a State, the State's government and university scientists take over and develop proper management practices to meet their individual needs. The process for

testing and establishing a native species of bee is much the same, except there is no need for a quarantine. On the average, the entire process takes 3 to 5 years to complete.

Finding the right pollinator for a given crop can have a significant economic impact. A recent example of this is the identification of a native bee—*Osmia lignaria*—as an excellent orchard pollinator.

In recent years, many factors have combined to reduce the number of honey bee colonies available for orchard pollination and the orchard crop has suffered for this reduction. Without pollination the orchard crop would fail and even under the best of circumstances, honey bees are not well suited to pollinating orchard crops.

Examining species of bees that visit apple and prune blooms, Mr. Torchio discovered that *Osmia lignaria* far surpasses the honey bee as an orchard pollinator and is biologically more suitable for the job. Based on later field test results, industrywide adoption of *Osmia lignaria* for pollination purposes should greatly increase orchard productivity.

Though non-apis bees don't live in hives like honey bees, the ARS researchers in Logan have learned to construct multiple-dwelling nesting sites, somewhat resembling high rise apartments for insects, that can be transported to fields needing pollination.

Undoubtedly, as more is learned about non-apis bees, management practices will be developed to tap their skills. Right now, the ultimate value of non-apis bees to range, forest, field, and ornamental and orchard crops is impossible to measure, but most bee researchers agree that non-apis bees already contribute millions of dollars to the agricultural economy.

It is expected that the world's population will approach 8 billion by the year 2000. To feed this many people we'll need to get maximum crop production from our available land resources. Non-apis bees can help do that.—*L.C.Y.*

In-hive Plumbing for Bees

CHANNELING BEE ACTIVITY toward honey production and crop pollination rather than in gathering water may be possible with the development of a simple, effective top waterer to bring "indoor plumbing" to the hive.

In hot climates, bees may spend as much time gathering water and cooling hives as they do in filling combs with honey or flitting from flower to flower to increase crop yields.

Bees were thousands of years ahead of humans in cooling their "homes" by evaporation. Honey bees fill cells with water and then buzz their wings over the cells to air-condition the hive. Scientists have found that bees die within 24 hours when no water is available and temperatures exceed 100 degrees. Other uses for water include thinning out honey for feeding, developing larvae and drinking. Some hives use as much as a gallon of water a day.

Water at the hive may keep bees from seeking it at watering troughs where animals may be "spooked," or from finding it near homes where persons may be working in a garden, on a lawn or washing a car.

The device, developed by ARS's Bee Research Laboratory, (2000 East Allen Road, Tucson, AZ 85719), and the Bee Disease Laboratory, (University of Wyoming, P.O. Box 3168, Laramie, WY 82071), is a modified hive section or "super." It fits on top of the hive like any other hive section and contains about 3 gallons of water. Supers in a hive could be compared to floors of an apartment house. There are about 10 frames of cells to a super. Honey is stored in the cells.

Other attempts at bringing water to the hive have been made from time to time but not in the quantity of the top waterer.

Much of the time bees are reluctant to take water from watering devices, but they seem to readily accept water from the top waterer. That may be because the water supers are coated on the inside with beeswax to make them watertight. Bees never have to leave the hive to get to the water. They crawl up from lower supers to the water, fill themselves and return to their own super.

There are three sections to the top waterer. The largest is the water tank itself, one section with a sponge-like material, and another small area or crawl space.

A slight opening at the bottom of the tank section is fitted with the sponge-like material that draws water much like a wick into the section where the bees take up water. The sponge offers a place for the bees to ingest water without drowning. A float board is also placed in this compartment in case the sponge "overflows." Bees can use the board to keep out of the water.

The top waterer was developed by entomologists Joseph O. Moffett and Adair Stoner and technician Arthur L. Wardecker for another study to protect bees during and after pesticide application. Stoner is from Laramie, and the other two from Tucson.

During the pesticide study, some hives were covered with burlap to confine the bees during spraying operations. Since the bees had to have water, the top waterer was developed.

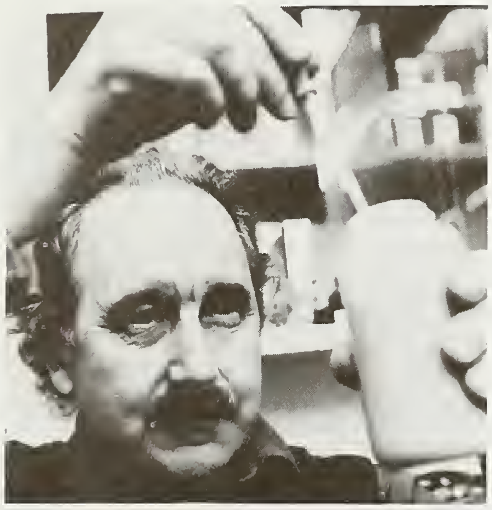
In the study, the researchers noted an increase in honey production before the insecticide spraying began and before the bees were confined, thus leading the entomologists to conclude the device could be an important innovation to all hives in hot semiarid regions.

Research on the top waterer will continue to obtain more data to see how much difference the waterers make in honey production and pollination activity.—*J.P.D.*

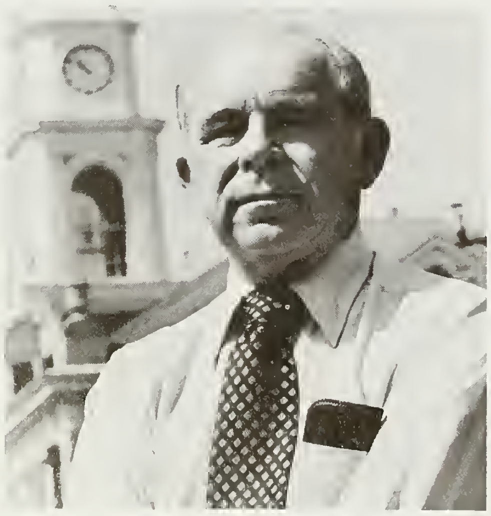
SCIENTISTS HONORED

For their outstanding achievements, eight individuals and one group of ARS employees recently received Distinguished and Superior Service Awards. Secretary of Agriculture Bob Bergland presented the awards at USDA's 31st Annual Honor Awards ceremony on May 26 in Washington, D.C.

DISTINGUISHED SERVICE:

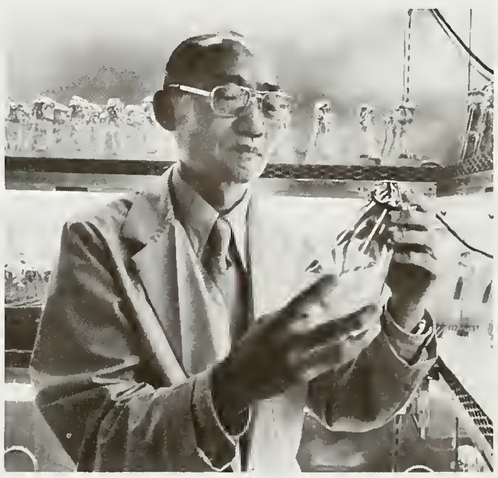


Dr. Theodor O. Diener, research plant pathologist, Beltsville, MD, for discovering the viroid and for continued pioneering research on the structure, properties, and replication of this new class of pathogen.



Dr. Charles F. Lewis, staff scientist for plant genetics and breeding, Beltsville, MD, for leadership and contributions to national and international agriculture in research and administration, carrying out ARS responsibility and USDA policy for reducing vulnerability of our plant germplasm resources.

Dr. Tien C. Tso, chief, Tobacco Laboratory, and plant physiologist, Beltsville, MD, for developing a safer tobacco and for improving other agricultural products for consumers through physiological, biochemical, and phytochemical research on tobacco.



SUPERIOR SERVICE:

Dr. Ernest L. Corley, Jr., director, Program Analysis and Coordination Staff, Washington, D.C., for leadership in developing and implementing national research planning, budgeting, and evaluation systems, and for staff work contributing to the successful reorganization of ARS.

Dr. John L. Creech, director, U.S. National Arboretum, Washington, D.C., for increasing the prestige and leadership of the Arboretum and USDA in national and international horticultural affairs.

Dr. Harold P. Dupuy, research leader, New Orleans, LA, for applying gas chromatography to solve flavor, marketing, and production problems affecting peanuts, vegetable oils, and sweet potatoes.

Dr. Vernon G. Pursel, research physiologist, Beltsville, MD, and Dr. Lawrence A. Johnson, research physiologist, Beltsville, MD, for developing a procedure to freeze swine semen for on-farm use of artificial insemination.

Sewage Sludge Land Utilization Research Group—BARC, Beltsville, Md., for team effort in responding to an urgent national need for research information on safe and beneficial use of sewage sludge on agricultural land. Led by Dr. James F. Parr, the group also included Walter H. Armiger, Dr. Wylie D. Burge, Dr. Rufus L. Chaney, Daniel Colacicco (with ERS), Dr. Eliot Epstein, Dr. Sharon B. Horneck, Dr. Paul B. Marsh, Dr. James D. Menzies (retired), Ms. Patricia D. Millner, Dr. Lawrence J. Sikora, Dr. Cecil F. Tester, Dr. John W. Walker (with EPA), and George B. Willson.—*M.M.M.*

Drainage for Higher Yields

THE LOWER Mississippi River Valley, with its fertile alluvial soil, long frost-free growing period, and annual rainfall that often exceeds 1,200 mm, has an enormous potential for increasing crop production.

As the demand for sugar and other food crops increases, farmers must increase yield per hectare. One method of increasing crop yield that farmers will certainly want to consider is subsurface drainage.

Research by agricultural engineer Cade E. Carter, of the Soil and Water Management Research Laboratory, (P.O. Drawer U, University Station, Baton Rouge, LA 70803) revealed that subsurface drainage was effective in increasing cane and sugar yields on poorly drained soils with a high water table.

Researchers determined the yield response of sugarcane to subsurface drainage. They measured the tolerance of sugarcane to wet soils by controlling the water table. The experiments were conducted on 40-m^2 concrete-bordered plots equipped to maintain the water table at any level from the surface of the soil to 150 cm below the surface.

The data showed that 120 cm deep water tables were more favorable for cane and sugar production than were shallower water tables. The number of crops harvested from one planting was also increased from the normal 3 to 5 crops.

Carter hopes that the research on subsurface drainage will result in designing an effective, low cost subsurface drainage system which will overcome the present 500 to 1,250 per hectare estimated installation cost. The use of subsurface drainage will also free valuable farm land for crop production and reduce the waste of land caused by the present ditch-drainage system.—*E.E.L.*

AGRISEARCH NOTES

Longer Lasting Lettuce

BY FOLLOWING ARS recommendations, wholesalers, retailers, and consumers can store shredded lettuce for 20 or more days—compared to 6 or 7 days often experienced with current handling methods.

Shredded lettuce is in heavy demand by restaurants, institutions, and fast-food chains because it is in ready-to-use form. This frees them from washing, trimming, and cutting. Also, shipping costs are reduced because all waste material, which may be as high as 50 percent, has been removed before shipping.

Chemists Harold R. Bolin and Allan E. Stafford, microbiologist A. Douglas King, and agricultural engineer Charles C. Huxsoll at ARS' Western Regional Research Center (800 Buchanan Street, Berkeley, CA 94710), found that higher temperature had the most adverse effect on storage life. Shredded lettuce shipped and stored at approximately 2° C (34° F) remained marketable for about 26 days compared to 10 days for the same product at approximately 10° C (50° F).

Also important in lettuce stability is a gas tight container that allows 50 percent longer storage life than common polyethylene bags, Sanitation during preparation and shredding of lettuce is important because larger numbers of bacteria reduce shelf life. Keeping lettuce dry during storage prevents bacterial growth and thus extends shelf life. The scientists also found that physical damage of lettuce shortened shelf life, and so recommend that only sharp knives be used for slicing.—*D.H.S.*

Detecting Sprouted Wheat

A rapid, simple color test is being substituted for visual inspection to detect sprouted wheat.

Visual inspection is not a true measure of sprouting damage. Germination is advanced before sprouting is seen, and affected kernels may be missed if the sprout has broken off.

Less than a year after its development at the U. S. Grain Marketing Research Center, the new test is being evaluated by USDA's Federal Grain Inspection Service and by State agencies in Idaho and Washington.

Sprouted wheat is considered damaged under federal grain grading standards. Excessive amounts of the enzyme alpha amylase produced during sprouting make flour milled from such wheat unsuitable for baking. White wheats are more susceptible than red wheats.

The test developed by ARS chemists Paul R. Mathewson and Y. Pomeranz of the U. S. Grain Marketing Research Center, (1515 College Ave., Manhattan, KS 66502), is a measure of alpha amylase and employs commercially available dyed amylose tablets also used in medical testing. Amount of alpha amylase, if any, is indicated by comparing a prepared sample with a color standard or by spectrophotometric analysis.

The test requires only 5 minutes incubation time, no elaborate equipment, and is sufficiently simple for use where laboratory facilities are minimal. Other methods for determining alpha amylase are time-consuming and require sophisticated equipment and trained personnel.—*W.W.M.*

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AGRISEARCH NOTES

Toward Better Sorghums

TOMORROW'S farmers may be asked to improve and expand crop production, reduce phosphate fertilizer use, and crop more soils that are marginal or low in phosphorus.

This task won't be impossible if phosphorus-efficient plants are developed, says ARS chemist Ralph B. Clark.

Dr. Clark says that sorghum and other plant genotypes differ in ability to use mineral elements in the soil. As a first step toward phosphorus-efficient sorghums, Dr. Clark, (Kiesselbach Crops Laboratory University of Nebraska, Lincoln, NE 68583), geneticist William M. Ross and physiologist Jerry W. Maranville of the University of Nebraska, Lincoln, screened sorghum breeding lines grown on phosphorus-deficient soil.

They identified KS35 and Martin among the most efficient and CK60-Korgi and a North Platte line among least efficient. The latter two lines developed severe phosphorus deficiency symptoms. KS35 and Martin did not and had higher dry-matter yields. On phosphorus-sufficient soil, dry-matter yields were not significantly different.

Another study suggests that phosphorus-efficient sorghums are also more susceptible to other mineral stresses. ARS soil scientist John C. Brown, Beltsville, Md., and Dr. Clark observed iron deficiency symptoms on some phosphorus-efficient sorghums grown on acid soil but none when grown on alkaline soil. Copper deficiency was also observed in one sorghum, and associated with the copper deficiency was high phosphorus.—*W.W.M.*

Reducing Downy Mildew

DOWNY MILDEW, a fungal plant disease, causes nearly $10 million worth of damage to cantaloups and honeydews each year in the United States.

Plant pathologist Claude E. Thomas, Subtropical Fruit and Vegetable Research Laboratory (P.O. Box 267, Weslaco, TX 78596), has been studying the environmental factors needed to develop downy mildew on cantaloups in south Texas.

Using a spore trap and weather instruments in a cantaloup plot, Dr. Thomas recorded temperature, dew, and wind velocity to determine the conditions necessary for spore infection and epidemic development. The tests revealed that downy mildew needs prolonged high humidity, mild temperatures, and 5–6 hour dew periods for infection. Once the cantaloup is infected, 5 days may be required to incubate the disease. Sufficiently long dew periods were the limiting factor.

Since the spores of downy mildew may be windborne as much as 100 miles and overwinter in the wild, they are a threat to cantaloups and melons throughout the United States. Spores start their attack on leaves. Leaf-to-leaf spread of the disease results in a disruption of photosynthesis and an end of further growth. Once the leaves die, cantaloups sun scald in the field because they lack leaf protection.

Knowledge about the spread of downy mildew disease on cantaloups will result in better spray control programs for the grower and more cantaloups for the consumer.—*E.L.*

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